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**Work Breakdown Structure (WBS)
and WBS Dictionary**

Prepared in accordance with DRD# 784MA-004

(NASA-CR-196448) WORK BREAKDOWN
STRUCTURE (WBS) AND WBS DICTIONARY
(Smithsonian Astrophysical
Observatory) 26 p

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Prepared for
George C. Marshall Space Flight Center
National Aeronautics and Space Administration
Marshall Space Flight

Submitted by
Smithsonian Astrophysical Observatory
60 Garden Street
Cambridge, MA 02138

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F. Cocuzzo 1/12/94
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Smithsonian Institution
Astrophysical Observatory

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WORK BREAKDOWN STRUCTURE (WBS) AND WBS DICTIONARY

1.0 Introduction

This document is intended to provide the framework for defining all work to be accomplished under the proposed contract for the Mission Support Program as defined by Section J-1 Statement of Work (SOW) of the RFP No.8-1-3-TA-50030 dated 11/2/93. The time period of performance of this contract will be from 3/1/94 through to the end of fiscal 1999.

In addition to providing the framework for the integration of the cost, schedule, and manpower planning, necessary to accomplish this work, it establishes the association among the WBS elements, the SOW, and the Technical Proposal.

2.0 Work Breakdown Structure (WBS)

The proposed WBS is displayed as table 2.1 . Since this WBS is a generic, it is intended to be used for the entire duration of the program. The operational time period of performance for each task is defined both in the Management and Work Plan (DR-784MA-001) and in the Logic Networks and Schedules (DR-784MA-005) submitted with this proposal.

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3.0 WBS Dictionary

WBS/SOW/Tech.Prop. Cross Reference is displayed as table 3.0

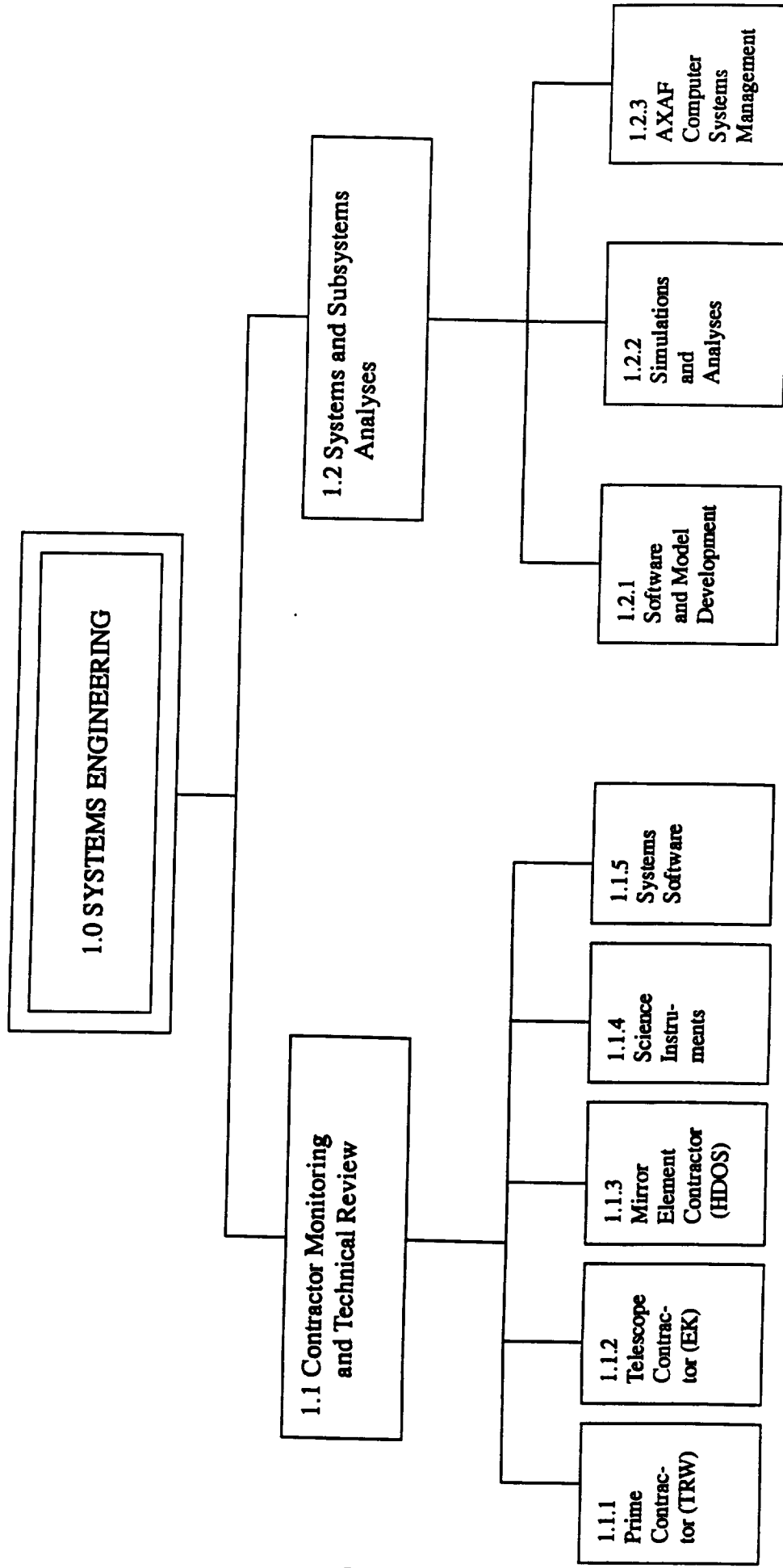
WBS Element	SOW REF	TECHNICAL PROPOSAL REF.
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WBS Element	SOW REF	TECHNICAL PROPOSAL REF.
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AXAF MISSION SUPPORT PROGRAM

WORK BREAKDOWN SCHEDULE (WBS)



TASK 1.0 SYSTEMS ENGINEERING

Task 1.1 Contractor Monitoring and Technical Review

Task 1.1.1 Prime Contractor (TRW)

This task is comprised of the science and engineering effort required to monitor the Prime Contractor, TRW. It consists of reviewing technical data and DRs as required by MSFC, attending key technical and program reviews, and critiquing and reporting on these data.

Task 1.1.2 Telescope Contractor (Eastman Kodak)

This task is comprised of the science and engineering effort required to monitor the Telescope Contractor, E.K. It consists of reviewing technical data and DRs as required by MSFC, attending key technical and program reviews, and critiquing and reporting on these data.

Task 1.1.3 Mirror Element Contractor (HDOS)

This task is comprised of the science and engineering effort required to monitor the Mirror Element Contractor, HDOS. It consists of reviewing technical data and DRs as required by MSFC, attending key technical and program reviews, and critiquing and reporting on these data.

Task 1.1.4 Science Instruments

This task is comprised of the science and engineering effort required to monitor the Science Instrument contractors. It consists of reviewing technical data and DRs as required by MSFC, attending key technical and program reviews, and critiquing and reporting on these data.

Task 1.1.5 Systems Software

This task is comprised of the science and engineering effort required to monitor the AXAF System Software activities. It consists of reviewing technical data and DRs as required by MSFC, attending key technical and program reviews, and critiquing and reporting on these data.

Task 1.2 Systems and Subsystems Analyses

Task 1.2.1 Software and Model Development

SAO is currently developing a suite of raytracing tools to allow the Mission Support Team and ultimately, the greater AXAF community, to accurately and flexibly model the optics. This major task is comprised of the science, software, and engineering effort required to develop and verify the software tools, and to develop the needed models.

Among these are:

- Raytrace software development to provide optical performance prediction of the HRMA and telescope in both the ground calibration and the on-orbit configurations.

- An input model to the raytrace system simulating an X-ray source.
- An input model that will provide a flexible means of simulating an aperture.
- Further development of surface reflection models for incorporating low spatial frequency surface errors into the geometric raytrace.
- An upgrade to the surface reflection model that will be able to handle polychromatic ray bundles re: the current monochromatic capability.
- An input model for X-ray scattering based on analytic or actual PSD distributions.
- An input model to incorporate the effects of aperture diffraction on the system.
- A generic model will be developed to simulate the effects of a detector on the focal plane measurements.
- Finite element structural and thermal models will be created to accurately predict the effects of gravity , thermal gradients, material instabilities, and motion dynamics, on the HRMA and optical bench/SI interfaces, for both ground and on-orbit performance predictions.

Task 1.2.2 Simulations and Analyses

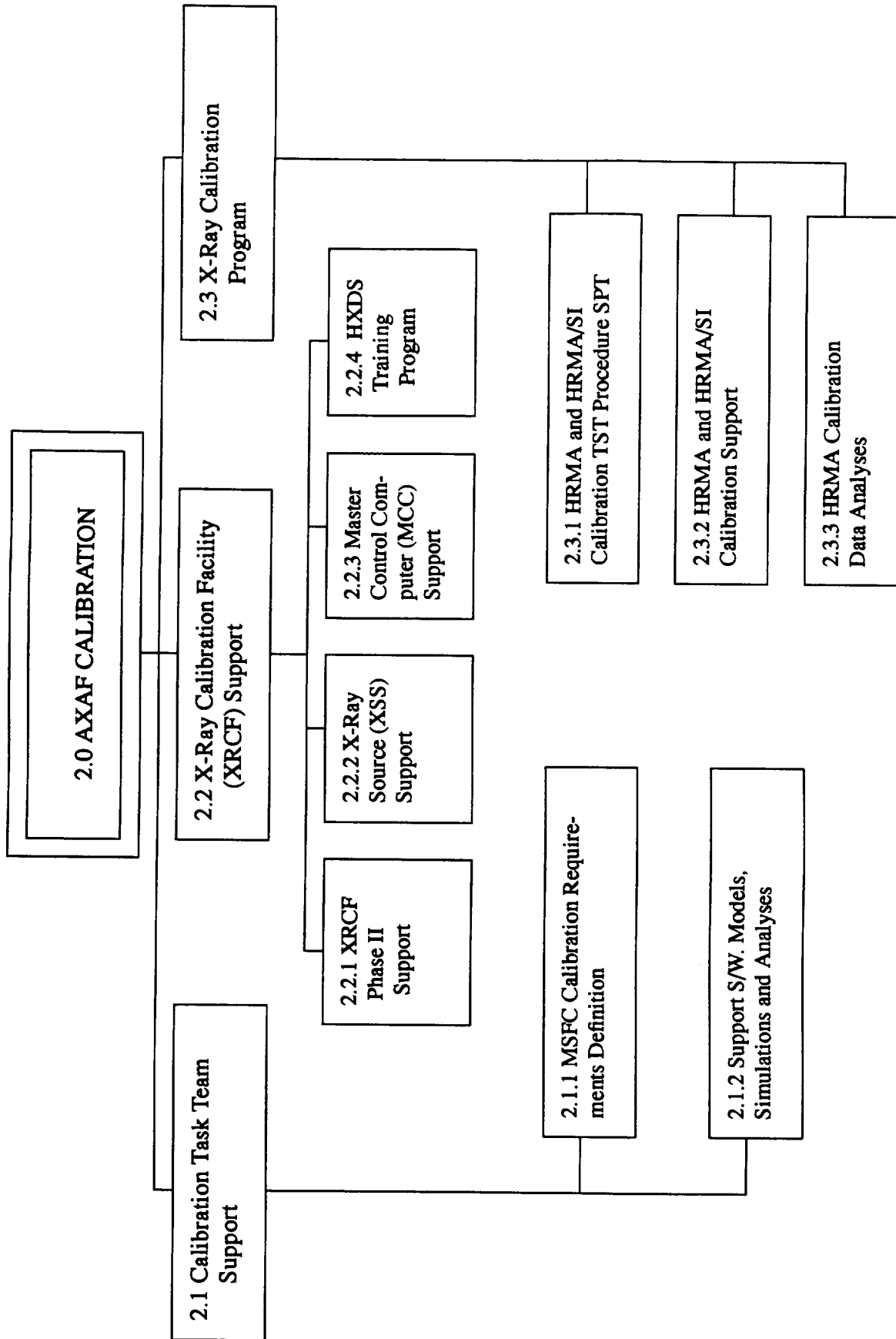
This task is comprised of the science, software, and engineering effort required to exercise the models described in Task 1.2.1 and to prepare analyses and reports.

Task 1.2.3 AXAF Computer Management

This task is comprised of the science and engineering effort required to specify, upgrade, maintain, and interface the many computers required by the Mission Support Team for analysis, and deliverable system hardware.

AXAF MISSION SUPPORT PROGRAM

WORK BREAKDOWN STRUCTURE (WBS)



TASK 2.0 AXAF CALIBRATION

Task 2.1 Calibration Task Team Support

Task 2.1.1 MSFC Calibration Requirements Definition

This task is comprised of the science support provided to MSFC to plan and define the AXAF, HRMA, and Science Instrument calibration requirements.

Task 2.1.2 Support Software Models, Simulations, and Analyses

This task is comprised of the SAO science effort to provide independent software models, simulations, and analyses to support Task 2.1.1

Task 2.2 X-ray Calibration Facility (XRCF) Support

Task 2.2.1 XRCF Phase II Support

This task is comprised of the engineering effort required to support the XRCF Phase II development effort as required by specific assignments from MSFC.

Task 2.2.2 X-ray Source (XSS) Support

This task is comprised of the science, engineering and procurement effort necessary to provide performance requirements, design and procurement specifications, and procurement and fabrication support to MSFC in the design, development, installation, and calibration of the XRCF X-ray source(s) (XSS).

Task 2.2.3 Master Control Computer (MCC) Support

This task is comprised of the software, science, and engineering effort provided to MSFC to support the specification, development, integration, and verification of the XRCF Master Control Computer system (MCC).

Task 2.2.4 HXDS Training Program

This task is comprised of the science, engineering, and software effort required to establish and conduct a program to train members of the HRMA/SI calibration test teams in the care and operation of the HXDS. It includes the preparation of a syllabus, preparation of course materials, and the conduct of the training sessions.

Task 2.3 X-ray Calibration Program

Task 2.3.1 HRMA and HRMA/SI Test Procedure Support

This task is comprised of the science, engineering, and software support to MSFC and TRW required to develop and verify the HRMA and HRMA/SI test procedures and scripts.

Task 2.3.2 HRMA and HRMA/SI Calibration Support

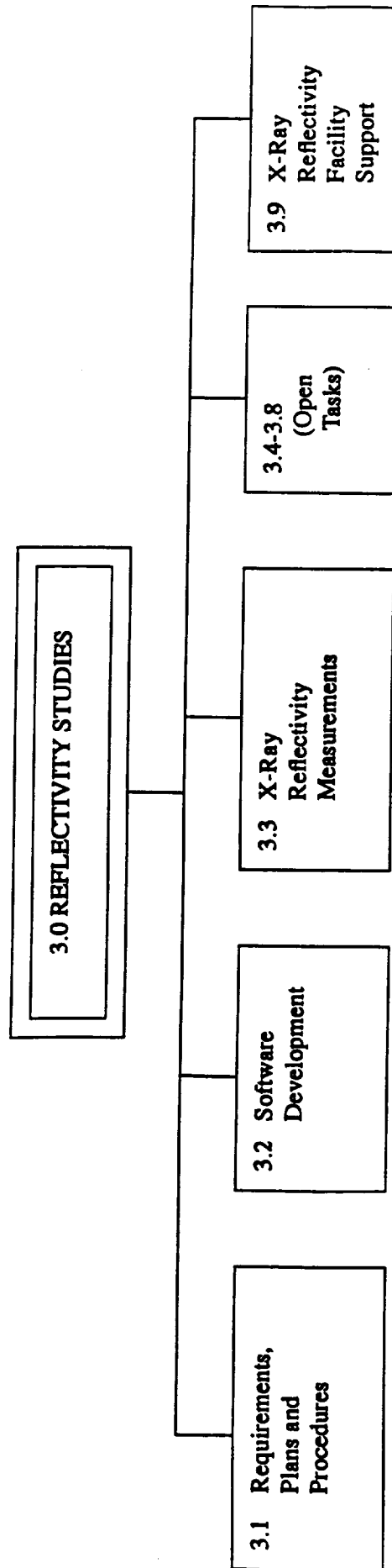
This task is comprised of the science, software and engineering labor required to provide SAO's contribution to the HRMA and HRMA/SI calibration and verification test effort.

Task 2.3.3 HRMA and HRMA/SI Calibration Data Analyses

This task is comprised of the science and software effort required to analyze HRMA and HRMA/SI calibration and verification data in order to predict on-orbit HRMA and HRMA/SI performance.

AXAF MISSION SUPPORT PROGRAM

WORK BREAKDOWN STRUCTURE (WBS)



TASK 3.0 REFLECTIVITY STUDIES

Task 3.1 Requirements, Plans, and Procedures

This task is comprised of the science, software, and engineering effort required to develop the requirements for reflectivity X-ray testing in support of the development and verification of the HRMA coating process, and the evaluation of the effects of contamination on reflectivity values. It results in the development of plans and procedures to accomplish the objective of evaluating the X-ray reflectivity of HRMA coating and contamination samples.

Task 3.2 Software Development

This task is comprised of the software effort required to develop both the X-ray facility operational software and the data analysis software required to accomplish the X-ray reflectivity measurements planned.

Task 3.3 X-ray Reflectivity Measurements

This task is comprised of the science and engineering effort required to conduct the specified X-ray reflectivity measurements and to analyze and report on the results.

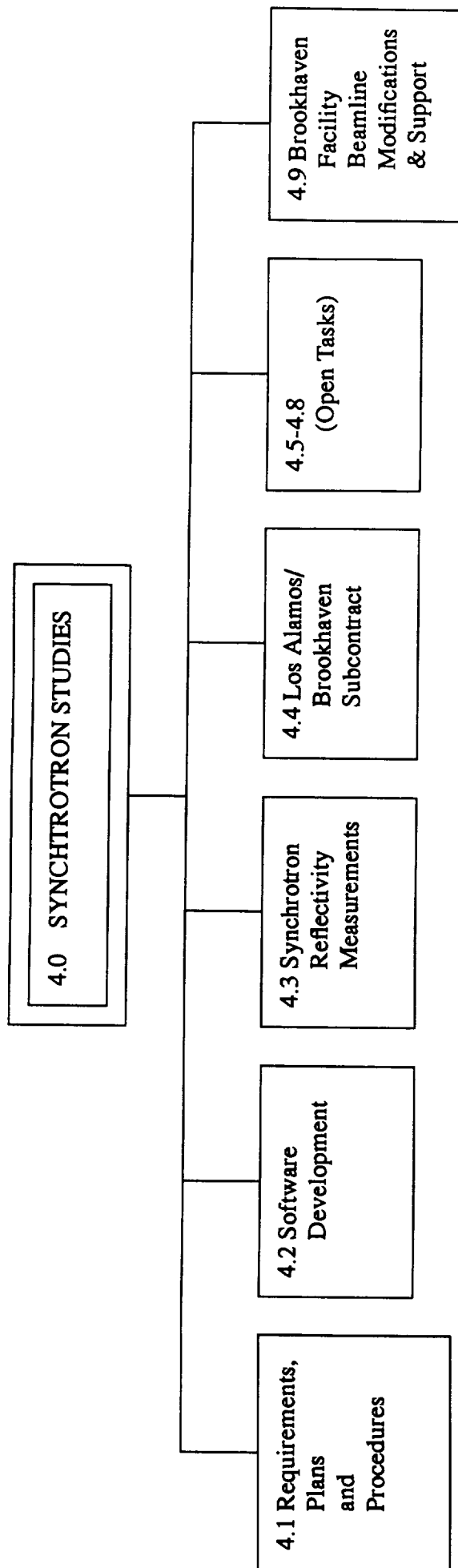
Task 3.4 - 3.8 (Open Tasks)

Task 3.9 X-ray Reflectivity Facility Support

This task is comprised of the engineering effort to upgrade and maintain the subject facility. It includes periodic calibrations and facility repairs as well as the design and fabrication of special test fixtures.

AXAF MISSION SUPPORT PROGRAM

WORK BREAKDOWN STRUCTURE (WBS)



TASK 4.0 SYNCHROTRON STUDIES

Task 4.1 Requirements, Plans, and Procedures

This task is comprised of the science, software, and engineering effort required to develop the requirements for synchrotron X-ray testing in support of the development and verification of the HRMA coating process, and the evaluation of the effects of contamination on reflectivity values. It results in the development of plans and procedures to accomplish the objective of evaluating the X-ray reflectivity of HRMA coating and contamination samples in the synchrotron facility at Brookhaven NY.

Task 4.2 Software Development

This task is comprised of the software effort required to develop both the synchrotron facility operational software and the data analysis software required to accomplish the synchrotron X-ray reflectivity measurements planned.

Task 4.3 Synchrotron Reflectivity Measurements

This task is comprised of the science and engineering effort required to conduct the specified synchrotron X-ray reflectivity measurements planned at Brookhaven and to analyze and report on the results.

Task 4.4 Los Alamos/Brookhaven Subcontract

This task consists of the management and cost accumulation for the Los Alamos/Brookhaven facility and accounts for the services of Dr. Richard Blake of R & D Services, PROP., of Santa Fe, New Mexico.

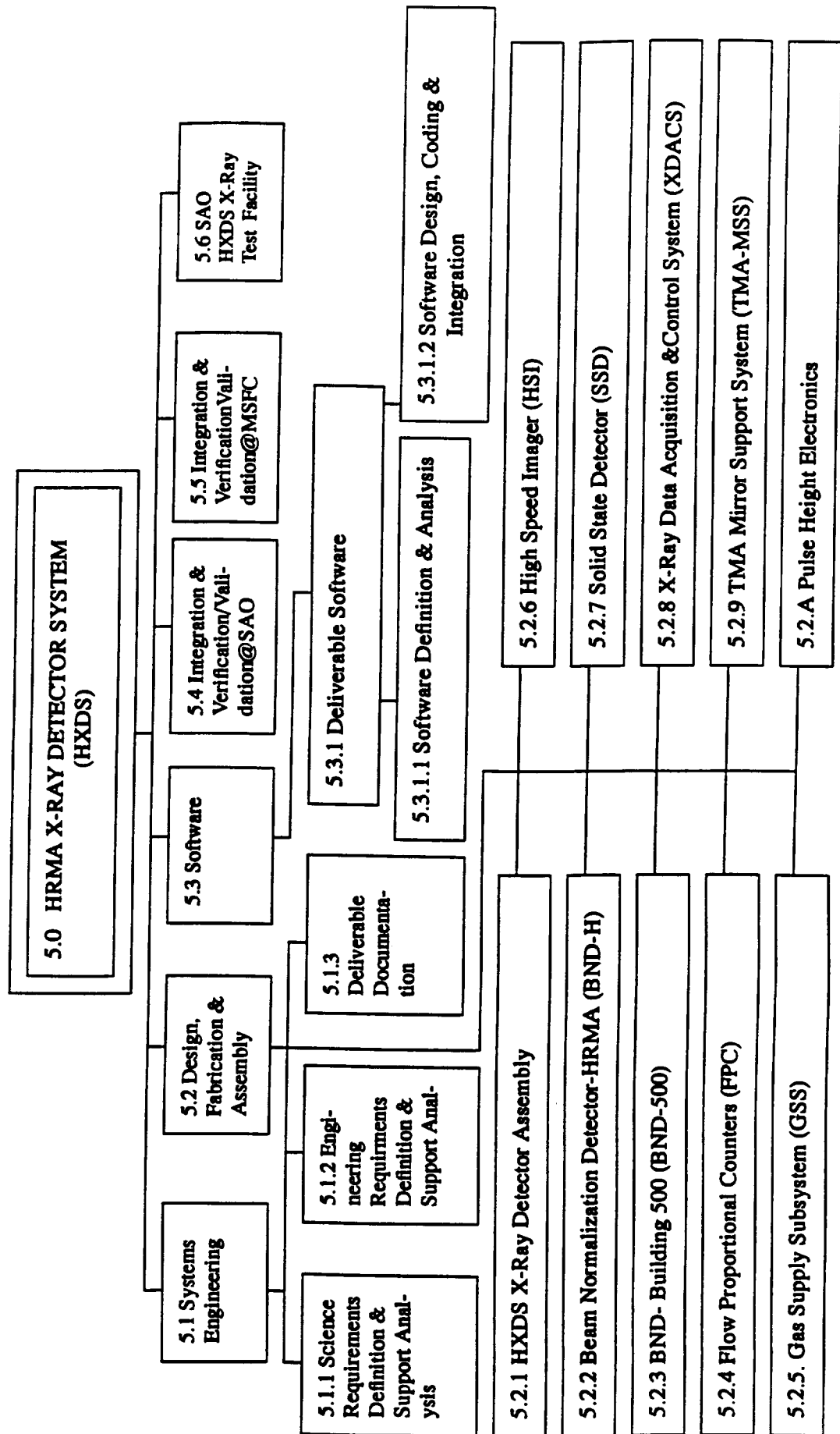
Task 4.5 - 4.8 (open tasks)

Task 4.9 Brookhaven Facility Beamline Modifications and Maintenance Support.

This task is comprised of the science and engineering effort to upgrade and maintain the subject facility. It includes periodic calibrations and facility repairs as well as the design and fabrication of special test fixtures and the procurement, installation, and calibration of required X-ray sensors and monochrometers.

AXAF MISSION SUPPORT PROGRAM

WORK BREAKDOWN STRUCTURE (WBS)



TASK 5.0 HRMA X-RAY DETECTOR SYSTEM (HXDS)

Task 5.1 Systems Engineering

Task 5.1.1 Science Requirements Definition and Support Analyses

This task is comprised of the science effort (in collaboration with the Calibration Task Team) to define the hardware and software requirements for the HXDS. It includes those analyses, sensor evaluations, and X-ray tests required to support the establishment of a CEI Specification for the HXDS.

Task 5.1.2 Engineering Requirements Definition and Support Analyses

This task is comprised of the engineering effort to convert the science HXDS software and hardware requirements into specific subsystem design specifications. It includes the required supporting electronic, structural, dynamic, and thermal analyses to establish each subsystem design.

Task 5.1.3 Deliverable Documentation

There are approximately 30 DRs deliverable on Task 5.0 HXDS (depending on the number of technical support DRs prepared). This task consists of the effort to collect and organize the data required and to prepare each DR. The DRs required are listed in the current SOW.

Task 5.2 Design, Fabrication, and Assembly

Task 5.2.1 HXDS X-ray Detector Assembly (HXDA)

The HXDA, located in the focal plane of the HRMA in the vacuum chamber at the XRCF, provides the three-axis positioning capability to the X-ray sensors; the HSI, the SSD, and two FPCs.

This task is comprised of the effort and material required to detail design, procure, fabricate, assemble, and verify this subsystem.

Task 5.2.2 Beam Normalization Detector - HRMA (BND-H)

The BND-H, located immediately in front of the HRMA in the vacuum chamber at the XRCF, positions four FPCs within an annulus just outside of the core of the X-ray beam which intercepts the HRMA. These FPCs are used to continuously monitor the quality of the X-ray beam. Three of the FPCs are fixed in quadrant positions with the fourth mounted on a two axis translation stage capable of fully traversing and sampling the entire X-ray Beam.

This task is comprised of the effort and material required to detail design, procure, fabricate, assemble, and verify this subsystem.

Task 5.2.3 Beam Normalization Detector - Building 500 (BND-500)

The BND-500, located in building 500 of the XRCF, in the guide tube near the X-ray source, is used to monitor the quality of the X-ray source close to the source. It consists of a fixed SSD and an FPC mounted on a two-axis translation stage called the

Guide Tube Mapper (GTM).

This task is comprised of the effort and material to detail design, procure, fabricate, assemble, and verify this subsystem.

Task 5.2.4 Flow Proportional Counters (FPC)

This is a critical X-ray sensor used on several subsystems of the HXDS.

This task is comprised of the effort and material required to specify and procure the counter bodies, to accomplish the specification, detail design, procurement, fabrication, assembly, and development of the flow counter windows and support structure, and to characterize and verify the assembled FPCs in SAO's X-ray test facility.

Task 5.2.5 Gas Supply Subsystem (GSS)

The GSS supplies and controls the flow of gas to the FPCs located at the HXDA and at the BND-H (MSFC will supply the gas system to support the FPC in the BND-500).

This task is comprised of the effort to detail design, procure, fabricate, assemble, and verify this subsystem.

Task 5.2.6 High Speed Imager (HSI)

The HSI, located on the HXDA at the focal plane is another critical X-ray sensor needed to meet the requirement for high count rate and improved spatial resolution in calibrating the HRMA.

This task consists of the effort and material required to specify, develop, and characterize unique high speed microchannel plates, and to accomplish the detail design, procurement, fabrication, assembly, and verification of this subsystem. It also involves the packaging of the support electronics in a hermetically sealed enclosure compatible with the chamber vacuum environment.

Task 5.2.7 Solid State Detector (SSD)

An SSD is located on the HXDA at the focal plane, and another is a part of the BND-500 in the guide tube in Building 500. This sensor also satisfies the HRMA calibration requirement for spectral resolution at high counting rates at an X-ray energy range from about 300 eV to 10 keV.

This task consists of the selection, characterization, and evaluation of candidate SSDs, and the detail design, procurement, fabrication, assembly, and verification of these subsystems.

Task 5.2.8 X-ray Data Acquisition and Control System (XDACS)

The HXDS XDACS provides functional control to all subsystems, data collection from the sensor electronics, GSS, and thermal monitoring electronics, and an interface to the MCC.

This task consists of the detail design, procurement, fabrication, assembly, and verification of this subsystem. It also includes the design, procurement, fabrication, assembly, and installation of all of the HXDS cabling both for test at SAO and at the XRCF.

Task 5.2.9 TMA Mirror Support System (TMA-MSS)

The TMA-MSS will allow the Test Mirror Assembly (TMA) to be mounted in the chamber (prior to the installation of the HRMA) to allow full system checkout of the HXDS and other auxiliary HRMA calibration equipments. This task consists of the final design, procurement, fabrication, assembly, and verification of this subsystem.

Task 5.2.A Pulse Height Analysis Electronics (PHA)

The PHA electronics support both the FPCs and the SSDs. They are designed to meet the requirements of high energy resolution coupled with low live-time errors and high count rate capability.

This task consists of the detail design, procurement, fabrication, assembly, development and verification of these electronics.

Task 5.3 Software

Task 5.3.1 Deliverable Software

This task is comprised of all software and science effort to provide operational, display, and quick-look analysis software for the HXDS. It consists of two parts:

Task 5.3.1.1 Software Definition and Analyses

Task 5.3.1.2 Software Design, Coding, and Integration.

Task 5.4 Integration and Verification at SAO

This task is comprised of all effort and material required to perform HXDS hardware/software integration, system level characterization, and system level verification of the HXDS at SAO prior to shipment to MSFC.

Task 5.5 Integration and Verification at MSFC

This task is comprised of all effort and material required to perform HXDS cabling, integration, and system level verification of the HXDS at the XRCF at MSFC.

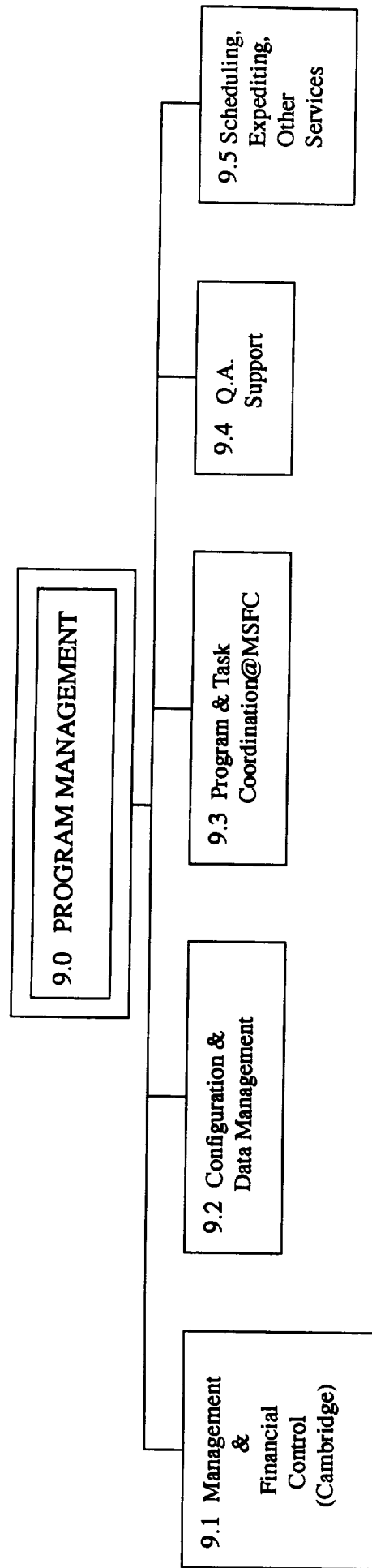
Task 5.6 HXDS X-ray Test Facility

The HXDS X-ray Facility has been developed by SAO at SAO Cambridge to enable the precision and efficient characterization of the HXDS X-ray sensors, and the integration and verification of the HXDS hardware and software in the appropriate vacuum X-ray environment.

This task consists of the effort required to calibrate the facility, design and build required fixturing, and perform routine maintenance procedures.

AXAF MISSION SUPPORT PROGRAM

WORK BREAKDOWN STRUCTURE (WBS)



9.0 PROGRAM MANAGEMENT

9.1 Management and Financial Control (Cambridge)

This element includes the overall management and program administration functions for the Mission Support Program at Cambridge. In addition to the Deputy Program Manager and the Program Administrator, it includes both Science and Engineering Project planning and cost estimating support.

Output includes monthly status reports, monthly financial reports, and Quarterly Reviews required by MSFC, and internal program reviews as scheduled by SAO's Associate Director's office.

9.2 Configuration and Data Management

This task element has two distinct parts.

Configuration Management is the effort to record and formally control deliverable documentation including drawings, lists, and data packages. It includes the administration of a Configuration Control Board (CCB) whose function is to manage the hardware/software configuration so that traceability is maintained by insuring that the integrity of the released baseline is protected.

Data Management is the logging, distribution, and control of all internal program documentation, whether provided to MSFC or not. It includes technical memoranda and trip reports, internal management actions, and the establishment and statusing of action lists for the entire program.

9.3 Program and Task Coordination at MSFC

On the Mission Support Program, the intimate nature of the relationship between the MSFC AXAF Project Office and SAO requires that the SAO Program Manager reside at MSFC. While responsible for the broad overall effort on the program, his prime responsibility is the coordination of SAO's efforts with those required by the AXAF Project Office and the major AXAF program contractors. This task consists of the effort of the Program Manager and his "in residence" staff in carrying out this key responsibility.

9.4 Quality Assurance (Q.A.) Support

The nature and requirements imposed by MSFC on the program deliverables through the DRs require Q.A. participation, oversight, and approval. Although a Manager Product Assurance reporting to the Associate Director exists at SAO, the various program personnel assigned by him to each program are chargeable to the program. This task is comprised of that effort.

9.5 Scheduling, Expediting, (and other Program Support Functions)

Scheduler(s) and an expeditor are assigned from the scheduling and Purchasing to support the AXAF Mission Support Program. This task is comprised of that effort.